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ABSTRACT

Two years ago, RAND published a report entitled "Fostering the Use of Educational Technology: Elements of a National Strategy." The report documented a series of analyses and workshops carried out during 1994 and 1995 and suggested elements of a national strategy that could foster the effective use of technology by the nation's elementary and secondary schools, with a special emphasis on actions that should be taken by the federal government. This testimony briefly reviews the elements of the strategy put forth two years ago with particular emphasis on the potential federal role in this strategy. Following this, is a brief discussion of a proposal that the federal government create a national institution dedicated to documenting and assessing the uses of technology in elementary and secondary education. These six proposed guidelines are discussed: (1) technology as a component of educational reform; (2) building recurring technology costs into school budgets; (3) access to the national information infrastructure; (4) monitoring equality of access to technology in traditionally disadvantaged populations; (5) seeking and using lessons from pioneering school applications; and (6) the federal role. (AEF)

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T E S T I M O N Y

Elements of a National Strategy to Foster Effective Use of Technology in Elementary and Secondary Education

Thomas K. Glennan, Jr.

CT-145

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Mr. Chairman and members of the Budget Committee Education Task Force:

I am delighted to have the opportunity to appear before you today to discuss technology in education and possible federal actions to improve its use. I work in the Washington office of RAND. RAND is a nonprofit institution that seeks to improve public policy through research and analysis. This statement is based on a variety of sources, including research conducted at RAND, however, the opinions and conclusions expressed are those of the author and should not be interpreted as representing those of RAND or any of the agencies or others sponsoring its research.

Two years ago, RAND published a report entitled *Fostering the Use of Educational Technology: Elements of a National Strategy*.[1] The report documented a series of analyses and workshops that we carried out during 1994 and 1995. In the course of these studies, RAND reviewed existing research on educational technology; convened five workshops of experts to discuss issues such as educational software development, plans to incorporate technology in schools, and the professional development of teachers; and studied a number of schools that were in the forefront of technology use. On the basis of our research, the report suggested elements of a national strategy that we felt would foster the effective use of technology by the nation's elementary and secondary schools, with a special emphasis on actions that should be taken by the federal government.

In my testimony today, I will briefly review the elements of the strategy that RAND put forth two years ago with particular emphasis on the potential federal role in this strategy. Following this, I want to briefly discuss a proposal that the federal government create a national institution dedicated to documenting and assessing the uses of technology in elementary and secondary education. Such an institution could respond to the frequently expressed concern that investments in educational technology are being made despite the fact that there is little research evidence that they will lead to improved student outcomes.

Educational Technology and the Improvement of Education

At the time we began our research, the popular image of educational technology was of computers and educational software, sometimes linked to more powerful servers to provide a computer-assisted instructional system. In fact, however, as shown in Table 1.1 from our report, technology has a wide range of uses in K-12 education. In some uses, technology

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[1] Thomas K. Glennan Jr. and Arthur Melmed, *Fostering the Use of Educational Technology: Elements of a National Strategy*, MR-682-OSTP/ED, RAND, Santa Monica, CA, 1996.

supports individual learning; in others it supports group learning activities. It can help to link the school and its staff and students to other parts of the community and to parents. Information technology can handle administrative functions in ways to free school staff for more important instructional or instructional planning activities. In short, technology is a tool in schools just as it is in most work places. In most instances its use cannot be easily separated from curriculum, pedagogy, and teaching skills in determining the source of an educational outcome. Because of the increasing ubiquity of technology in schools and because of the many uses to which it can be put, the commonly asked question, "Does technology improve student's educational performance?" is difficult to answer. The uses of technology are too varied and situation specific to permit the general answer sought by the question.

Table 1.1[2]

Some Examples of the Use of Technology in Support of Elementary and Secondary Education

Type of Educational Activity	Examples of Technology Use
Support for individual learning activities	Stand-alone drill and practice units for particular skills
	CD-ROM- or Internet-accessed resource bases
	Assistance in searching for information
	Communication with experts
	Computational and writing tools (word processors and spreadsheets)
	Simulations that help visualize systems or mathematical or scientific concepts
Support for group learning activities	E-mail supporting group communication
	Presentational software to allow group to collaborate on presentation
	Video to support presentation of community-based projects
	Communication allowing collaboration among schools for collection and analysis of data
Support for instructional management	Integration of curriculum, standards, and assessments
	Management of student portfolios and exhibitions
	Support for development of individual student instructional plans or contracts

[2] MR-682, p. 4.

Communications	Communication for remote locations (such as rural schools) that permit access to expertise, resources, and improved learning environments
	Improved communication among students, teachers, and parents
Administrative functions	Support for attendance, accountability functions, and other administrative activities

On the basis of our research, we reached a number of conclusions, the first two of which bear on the potential value of increased use of technology in schools.

1. *Educational technology has significant potential for improving students learning.*

Both research and the experience of practitioners suggest that, properly implemented, technology can support improved student learning. Most of this research and experience has dealt with small, individual applications of technology. However, a small proportion of the nation's schools have intensively and effectively implemented a variety of educational technologies in ways that engage and motivate students to achieve performance levels and improvements consistent with the nation's educational goals. They have done this by using technology to

- tailor learning experiences more clearly to learner needs and abilities
- provide students with access to resources and expertise outside the school
- support more authentic assessment of student's progress
- manage and guide the learning activities of the students.

On the basis of the experience of these schools, and of numerous smaller, less systemic applications of technology, we conclude that the modern reform agenda for schools, particularly that part of the agenda dealing with providing an instructional program that enables all students to meet challenging standards, can be strongly supported by technology. Indeed, we think this agenda may not be achievable without the use of technology to support the functions outlined above.[3]

2. *Extensive use of technology in schools has the potential to promote significant school restructuring and expand the time and motivation for student learning.*

We share the view of Louis Gerstner, quoted in the first chapter of this report:. "[Information technology] is the force that revolutionizes business, streamlines government and enables instant communications and the exchange of information among people and institutions around the world."[4] However, few schools (or school systems) have had the levels of technology required to support such restructuring, fewer have had technology long enough for

[3] MR-682, pp93-94.

[4] Remarks of Louis V. Gerstner, Jr., Chairman and CEO—IBM Corporation, at the National Governors' Association Annual Meeting, Burlington, Vermont, July 30, 1995.

restructuring to have been fully worked out, and most efforts have not been extensively documented.

Nonetheless, existing research and the experience of the pioneer schools we consulted are promising and suggestive. Students, teachers, and administrators report taking new roles. Technology has been used as an instructional management tool. Students and their parents report they are more motivated. There is some evidence of improvement on traditional measures of student outcome.

However, the evidence from these schools must be put into an appropriate context. These schools, as early adopters of technology, are clearly exceptional. Moreover, the concepts of learning and instruction that these schools have used are not new. They have foundations in the work of Dewey, in the progressive school movement, and in the modern findings of cognitive scientists. These concepts are also intuitively appealing and, in the hands of skilled practitioners, have proven effective. However, past reform movements built on these concepts have foundered. Systemic barriers—inadequately trained teachers, the lack of clearly defined standards, the effort required to manage many independent student learning activities, and lack of success in gaining broad public support—prevented high performance and widespread adoption.

Technology has the potential to deal with some of these past problems. It can support the management of complex, standards-related instructional processes in ways that have previously been achieved by only the most skilled teachers. It can facilitate communications among teachers so they can collaborate more effectively. Technology can also promote communications among schools, students, and parents that fosters greater accountability and public support.

The potential for success may also be improved because technology is being introduced into schools in a time of broader, systemic reform. The development of clearer and higher standards and associated assessments, a major objective of the systemic reform movement, can sharpen the understanding of a community's goals for education and can sharpen the performance of schools in meeting those goals. Standards and assessments should provide a necessary discipline to a community's schools. At the same time, schools of education, state accreditation agencies, and school systems are being urged to rethink and align their programs with high standards.

But it is important to reiterate that while the early experience with pioneer, technology-rich schools appears promising, it remains to be seen whether technology-rich learning environments can be implemented in large numbers of schools with comparable outcomes.[5]

As these quotes from the Report suggest, I believe that technology can play an important or even a crucial role in improving American education. However, it will do so if it is combined with other actions to improve the capabilities of schools, students, and parents to make use of such technology. In particular, the introduction of technology must be coupled with extensive activities to foster teachers' capabilities to effectively incorporate technology in their programs and by continued efforts to improve educational software and content.

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[5] MR-682, pp. 94-95.

Elements of a National Strategy to Foster the Effective Use of Technology in K-12 Education

Given the modest scope of our research, it would have been presumptuous of us to propose a full national strategy to effectively increase and improve the use of technology in K-12 education. Instead, we proposed six broad guidelines.[6]

1. The introduction of educational technology into schools should occur as a component of a broader effort of school reform to improve the learning of all children.
2. Over time, the recurring costs of educational technology should be built into school budgets as a normal component of recurring costs. Major responsibility for financing and implementing technology clearly lies with state and local school authorities.
3. Public authorities at all levels should work with the private sector to see that all schools have access to the national information infrastructure at reasonable costs.
4. All levels of government should monitor the access to technology that exists for traditionally disadvantaged populations and be prepared to do what is possible to ensure equality of access.
5. All levels of government should seek to learn and use the lessons from schools and school districts that pioneer in the creation of technology-rich learning environments.
6. The federal government's role should involve leadership, funding of research and development, dissemination of information on effective practice, and managing existing programs in ways that capitalize on the benefits of educational technology.

In the following paragraphs I review progress along each of these guidelines briefly.

1. Technology as a component of educational reform

My impression is that the rapid growth in acquisition of technology for schools has made it difficult to coordinate the use of technology with a reform agenda. In 1994 we estimated that the nation's schools spent about $3 billion on technology and software; it is predicted that this year, expenditures will be over $5 billion. On the whole, responsibility for these expenditures lies with the components of school systems concerned with capital improvements rather than instructional design. Not surprisingly, anecdotal reports suggest that initial communication among these components was often limited.

Federal and state policies may be helping to improve this situation. Virtually all the major funding programs require technology plans that include attention to how the technology will be used and how teachers will acquire necessary skills. In particular, this

[6] MR-682, pp100-101.

has been true for federal programs such as the Technology Literacy Challenge that has been managed by the same staff responsible for Goals 2000.

However, the real issue is whether the acquisition and deployment of technology at the state and local level meshes well with other reform initiatives. I have seen little systematic information on this.

2. Building recurring technology costs into school budgets

At the time we began our study, there seemed to be little acknowledgement of the need to budget for the continuing costs of maintenance and modernization in regular school budgets. Equipment was purchased from grant funds and often kept until it ceased to function. Researchers doing fieldwork in schools frequently reported closets and storerooms filled with old computers and related equipment.

Today the rhetoric of technology planning universally recognizes the importance of these costs. However, it is easier to talk about them than to do something about them. Significant proportions of funding for technology acquisition now come from federal, state, and private grants as well as from local and state bond issues. This may be appropriate for covering the initial costs of ramping up to higher levels of technology use, but it must be followed by funding that is built into regular school budgets. Again, we have little systematic information on these school practices.

3. Access to the national information infrastructure

The rate of increase in both school and individual classroom access to the Internet has been impressive. In 1994, 35 percent of the nation's schools had Internet access; by 1996 the percentage had risen to 65 percent. In most schools, the access is to a single point, perhaps the principals' office. However, the percentage of instructional rooms with such access had risen from 3 percent to 14 percent. Providing it is continued, the component of the Universal Service provisions of the 1996 Telecommunications Act providing subsidies to schools and libraries for telecommunications services should advance the objective of providing universal access still faster. These subsidies are expected to total approximately $2.25 billion annually.

4. Monitoring equality of access to technology to traditionally disadvantaged populations

Many policymakers and other observers are concerned that the access and use of technology will favor the more advantaged and privileged populations of society. Many have expressed concern that the increased use of technology will further worsen the perceived

inequality of educational opportunity imbedded in our current K-12 education system. While technology advocates have argued that educational technology has the potential to be particularly helpful in meeting the needs of at risk students, the question of whether this potential is achieved is important.

Virtually all of the federal government's programs dealing with educational technology place emphasis on the needs of at risk populations. Grants to states are made according to formulas giving weight to poverty and other indicators of exceptional educational need. The universal service provisions of the 1996 Telecommunications act provides much deeper subsidies to schools that serve poorer populations than to those serving more privileged populations. This is often the case in state programs as well. However, most of these funds provide for equipment. The nation has little systematic understanding of whether the effective use of educational technology is equally likely for poor children as for the more affluent.

Perhaps more importantly, much learning takes place at home where the disparity between income groups in access to computers and the Internet is much greater than in schools. The impact of this disparity is unknown and only a few isolated local programs explicitly address the problem.

To date, the monitoring of access to technology has been limited to counting computers, local area networks, or internet access. It is time to begin to dig deeper than the simple access to hardware to understand potential disparities in the uses of technology among population groups.

5. Seeking and using lessons from pioneering school applications

The diffusion of new technologies typically follows an "S" shaped curve. As the technology begins to diffuse, early adopters who are in situations where the technology has great potential or who simply recognize potential benefits of the technology acquire and exploit the technology. These early adopters often develop ways to use the technology and can serve as guides to those who subsequently adopt that technology. In the RAND study, we examined a number of schools who had exciting and reportedly effective programs.

Education is a largely public activity controlled by political forces that tend to evenly spread resources such as those associated with educational technology. This may make it difficult to actively follow a policy that supports the early adopters with the intent of using their experiences to guide later adopters. Nonetheless, there are still pioneer schools that are out ahead of the pack. In its report, RAND argued that a more systematic effort should be made to seek out these early adopters and distill lessons from their experiences for other schools and districts. To our knowledge, there has been no such recent effort to do this. Such

information as exists seems more the product of enterprising journalists and ambitious educational entrepreneurs than of a national research effort seeking to provide helpful and reliable information to a wider public.

6. The federal role

In our report, we envisioned a quite traditional role for the federal government in the area of educational technology. In particular, we said: [7]

> While the major burdens for acquiring and using educational technology lie with schools, school systems and states, there are important (and quite traditional) roles the federal government should play. These encompass four major classes of activities.
>
> 1. Continuing advocacy and leadership for school reform, emphasizing the potential that technology has for improving student performance.
> 2. Creating and disseminating high-quality information concerning the effective deployment and use of education technology.
> 3. Fostering the development of assistance organizations that will help schools and school systems successfully implement effective, technology-enabled schools.
> 4. Sustaining a vigorous and relevant program of research and development related to educational technology

In my view, the President, Vice President, and the Secretary of Education have played a continuing and important role in providing leadership for both school reform and for the role that technology can play in that reform. The Department of Education has created a small number of assistance organizations that are charged with helping schools make effective use of technology. I do not know enough of their activities to judge the quality of their work. The President's Committee of Advisors on Science and Technology has issued a report to the President calling for a much-strengthened program of R&D on technology in K-12 education.[8] An interagency working group has been created by the President's Science Advisor to recommend an improved program of R&D related to "learning technologies," in part in response to this committee's report.

In my judgment, however, the second potential federal activity, "creating and disseminating high-quality information concerning the effective deployment and use of education technology" has not been adequately or forcefully attended to. Perhaps the ongoing planning for future R&D will provide for this. However, the fragmented responsibility for R&D among government agencies and the competing demands of other important and well established interests in and around those agencies, appear to have

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[7] MR-682, p 104.

[8] The President's Committee of Advisors on Science and Technology, Panel on Educational Technology, *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States*, Washington DC, March 1997.

slowed planning for such efforts. Moreover, some of the information needs require the adoption or development of new methods for collecting and analyzing data that are not commonly used in educational research and statistics.

In the course of our discussions with experts in the field, a number have suggested that the federal government create a new institute outside the government to promote the assessment of the use of educational technology. Such an institute might provide a sharper focus and more concentrated planning for such efforts. Departments and agencies having a role in education and educational technology might jointly fund this institute.

Such an institute could have several important functions including:

1. Develop a broad national strategy for collecting, analyzing, and disseminating information on the use and effectiveness of educational technologies in K-12 education.
2. In collaboration with Department of Education and National Science Foundation staff, leadplanning for national data collection efforts intended to describe the use and effectiveness of educational technologies across the United States. In this planning, careful attention should be provided to models for data collection and assessment that have been developed in areas such as medicine and public health.
3. In collaboration with Department of Education staff, lead planning for a program of data collection concerning management practices and resource requirements for educational technology in K-12 education. This should proceed quickly since the resources devoted to educational technology are increasing so rapidly.
4. Search out academic and practice-based research on effectiveness of technology applications in K-12 education. The results of these searches could be synthesized in periodic reports and made available on a central Web site.
5. Develop common data collection protocols to be used by government grantees and others developing new programs to provide some measure of commonality among evaluations of these efforts.
5. Conduct regular and frequent workshops and conferences bringing together researchers, practitioners, industry representatives, and government officials to discuss and advise on important issues concerning the use and management of educational technology that should be incorporated in the federal data collection program.

An institute such as this might have a permanent core staff but also engage government employees, researchers from universities, and individuals from the private sector as research fellows and associates.

I appreciate the opportunity to appear before you today and will be glad to try to answer any questions that you may have.